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THE BRITISH TECHNOLOGY GROUP(U) OFFICE OF NAVAL  
RESEARCH LONDON (ENGLAND) J F BLACKBURN 17 AUG 87  
ONRL-7-022-R

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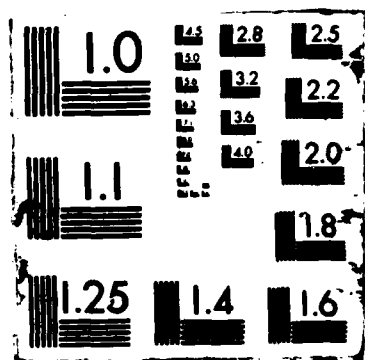
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# ONRL Report 7-022-R

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The British Technology Group

Dr. J.F. Blackburn

17 August 1987

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U.S. Office of Naval Research, London

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SECURITY CLASSIFICATION OF THIS PAGE

AD-A185 064

## REPORT DOCUMENTATION PAGE

1a. REPORT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>			1b. RESTRICTIVE MARKINGS	
2a. SECURITY CLASSIFICATION AUTHORITY			3. DISTRIBUTION / AVAILABILITY OF REPORT <b>Approved for public release; distribution unlimited</b>	
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE				
4. PERFORMING ORGANIZATION REPORT NUMBER(S) <b>7-022-R</b>			5. MONITORING ORGANIZATION REPORT NUMBER(S)	
6a. NAME OF PERFORMING ORGANIZATION <b>US Office of Naval Research Branch Office, London</b>		6b. OFFICE SYMBOL (If applicable) <b>ONRL</b>	7a. NAME OF MONITORING ORGANIZATION	
6c. ADDRESS (City, State, and ZIP Code) <b>Box 39 FPO, NY 09510</b>			7b. ADDRESS (City, State, and ZIP Code)	
8a. NAME OF FUNDING / SPONSORING ORGANIZATION		8b. OFFICE SYMBOL (If applicable)	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)			10. SOURCE OF FUNDING NUMBERS	
			PROGRAM ELEMENT NO.	PROJECT NO.
			TASK NO.	WORK UNIT ACCESSION NO.
11. TITLE (Include Security Classification) <b>The British Technology Group</b>				
12. PERSONAL AUTHOR(S) <b>Dr. J.F. Blackburn</b>				
13a. TYPE OF REPORT <b>Technical</b>	13b. TIME COVERED FROM _____ TO _____	14. DATE OF REPORT (Year, Month, Day) <b>17 August 1987</b>	15. PAGE COUNT <b>9</b>	
16. SUPPLEMENTARY NOTATION				
17. COSATI CODES			18. SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP		
<b>09</b>	<b>03</b>		<b>Technology</b>	
<b>09</b>	<b>02</b>		<b>Industrial</b>	
			<b>Innovation</b>	
			<b>Electronics</b>	
			<b>Computer</b>	
			<b>Systems</b>	
19. ABSTRACT (Continue on reverse if necessary and identify by block number)				
<p>The British Technology Group, when it was established in 1981, incorporated the National Research Development Corporation and the National Enterprise Board. Its primary purpose is to encourage and facilitate transfer of new ideas and technology from university and government laboratories to industry. This report reviews the Group's current activities.</p>				
20. DISTRIBUTION / AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS			21. ABSTRACT SECURITY CLASSIFICATION <b>UNCLASSIFIED</b>	
22a. NAME OF RESPONSIBLE INDIVIDUAL <b>C.J. Fox</b>			22b. TELEPHONE (Include Area Code) <b>(44-1) 409-4340</b>	22c. OFFICE SYMBOL <b>310</b>

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted  
All other editions are obsolete

SECURITY CLASSIFICATION OF THIS PAGE

UNCLASSIFIED  
GPO: 1986-607-044

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## THE BRITISH TECHNOLOGY GROUP

### 1 INTRODUCTION

In July 1981, The British Secretary of State for Industry announced that, effective immediately, the National Research Development Corporation (NRDC) and the National Enterprise Board (NEB) would operate together under the name of the British Technology Group (BTG). BTG's investment in technology projects in industry and universities in fiscal year 1985-86 was over £10 million (\$16.5 million) and is expected to reach £18 million per year (\$29.7 million at today's exchange rate) by 1989.

### 2 ACTIVITIES OF THE BTG

#### Technology Transfer

BTG promotes the transfer of technology from UK public sector sources to British industry. BTG patents or otherwise protects an invention, identifies industrial companies that are interested in using the invention, and negotiates license agreements for patents, knowledge, or software. BTG also licenses internationally, and 70 percent of its income comes from overseas.

#### New Initiatives with Sources of Invention

The portfolio of intellectual property available for licensing at BTG is continually increasing by the results of research assigned to BTG for exploitation.

These inputs come mainly from public sector research and development centers in the UK. Included are more than 50 universities and colleges, about 40 Polytechnic Institutes, some 100 Research Council establishments and units, and 15 major government laboratories.

BTG is offering trial funding arrangements with a small number of universities in which sums of £100,000 to £300,000 (\$165,000 to \$495,000) are earmarked for investment by BTG over a 3-year period at the institution.

#### BTG Conferences

BTG runs regional conferences on the theme of industrial innovation from academic research. Speakers and delegates come from universities, industry, and governmental organizations. Recent conferences were held at the university of Leeds, Imperial College of Newcastle, the University of Sheffield, and the University of Dundee.

#### BTG Research Fellows

The title "BTG Research Fellow" indicates that the holder has a significant role in a project at a level equivalent to that of a postdoctoral research student. Six such awards were made during the last year.

#### Finance for Industrial Innovation

BTG finances technical innovations by private sector companies through providing project finance, loans, or equity participation. Funding is offered on commercial terms and there is no formal maximum size of investment. Other sources of venture capital and bank finance are sought for larger projects.

BTG recovers its investment through a levy on sales of the resulting product or usage of the resulting process. Equity participation may be more appropriate where a technology is best developed by creating a new company, or expanding an existing one, or if the successful growth of a company is critically dependent on technical innovation.

#### Prizes and Awards

Fourteen organizations with whom BTG worked during 1986 have received special awards.

#### Private Inventors

During 1985-86 BTG received over 400 ideas from persons who did not have the backing of a company, academic institution, or laboratory. Only a very small number of these were suitable candidates for development funding or for exploitation.

The following sections will summarize the work in the various divisions of BTG.

### 3 SCIENCE

The main activities of the Science Division are in human medicine, animal health and husbandry, diagnostics, plant protection, biotechnology in health care, food and agriculture, chemistry and materials, and chemical and process engineering.

The number of new projects in the 1985-86 year was 50 percent greater than during the previous year.

#### Human Medicine

Further funding was provided over the past year to the Universities of Essex, Birmingham, Cambridge, and Loughborough as well as to University College Hospital and the National Institute for Medical Research.

Patents and know-how at BTG cover products which combat diseases including hemochromatosis, sickle-cell anemia, thalassemia, arthritis, and cancer.

- o The University of Nottingham has been funded for a study on novel methods of linking cytotoxic agents to monoclonal antibodies for use in the treatment of cancer.
- o The University of Birmingham is funded for a study to improve the uptake of biologically active phosphates into the target cells.
- o The Institute of Cancer Research has with BTG support developed a new drug with potential in the control of breast cancer.
- o The University of Edinburgh has identified thromboxane antagonists as possible agents for the treatment of cardiovascular disease. G.D. Searle has been licensed to develop this product.
- o The Wellcome Foundation has exercised its option to develop the Campath I monoclonal for bone marrow transplantation.

During the past year BTG has agreed to develop arrangements with Glaxo for orally active pharmaceuticals; Advanced

Therapeutic Systems Corporation for pessaries, suppositories, and wound management products; and Charles F. Thackray for cements for Prosthetic surgery.

#### Animal Health and Husbandry

BTG has committed significant funds to develop poultry vaccines at Houghton Poultry Research Institute. An agreement was signed with Glaxo Animal Health, Ltd. to develop a vaccine for the treatment of calf pneumonia.

- o Institute for Research on Animal Disease (IRAD) is investigating the prevention of mastitis in cattle.
- o The Animal and Grassland Research Institute is concerned with the delivery of synthetic growth hormones for cattle.
- o The University of Southampton has developed a liver fluke vaccine.
- o The Hannah Research Institute is investigating immunological methods of controlling fatty tissue.

#### Diagnostics

Monoclonal antibodies specific to cross-linked fibrin degradation products have been successfully incorporated in a simple two-site enzyme-linked assay at the National Institute for Biological Standards and Control. BTG is funding a program to assess their use in a variety of coagulation-related disease states and to monitor thrombolytic therapy.

Other diagnostic work is being funded at the London School of Hygiene and Tropical Medicine, the Royal Free Hospital, QCA Ltd., the Wellcome Foundation Ltd., Hybritech Incorporated, Omogene Science Incorporated, Marion Laboratories, and King's College, London.

#### Biotechnology

The University of Warwick is working on a project to isolate, culture, and screen strains of cyanobacteria (Blue-green algae). Also, BTG is supporting a project at Lancashire Polytechnic directed to improving fermentation techniques for cyanobacteria and other photosynthetic microorganisms. Other work in

biotechnology is underway at the University of Newcastle and Imperial College London.

#### Materials and Chemical Engineering

An exclusive EEC Manufacturing license has been concluded with the Italian firm SNIA Fibre for the production of high-modulus polyethylene fibers using techniques developed at the University of Leeds. Also negotiations are underway for its manufacture in Japan. An agreement was concluded earlier with Celanese Corporation in the US.

Special techniques for drawing polymers so as to enhance their physical properties were developed at Leeds University. BTG has concluded a license with BP Chemicals Ltd., to use this technology.

A 2-year program at Hatfield Polytechnic is extending an investigation of metal coordination compounds and their use in medium-temperature coating of substrates with metals and metal derivatives.

Using BTG funding, the Institute of Food Research installed at its Norwich Laboratory a pilot unit for the extraction of solids and liquids using supercritical carbon dioxides. The institute has now established a significant research and evaluation program to extend the use of CO<sub>2</sub> for the extraction of food components such as emulsifiers and flavorings.

At Lanchester Polytechnic, BTG is supporting studies on the effects of ultrasound on chemical reactions in terms of the nature and distribution of the end products and the rate of reaction.

Two 1-year programs on novel ignition devices are being funded by BTG at Imperial College. One concerns the use of compact plasma generators to initiate and maintain combustion in gas turbines and the other is investigating the design and operation of an innovative spark plug devised by a private inventor, Mr. Tony Lee.

BTG is sharing the cost at Powdrex Ltd. in the development of novel powder forms of metallurgical alloys that can be readily sintered into high-density, high-

integrity products whose properties are superior to those obtained by conventional metallurgical processing.

Fulmer Components Ltd. and BTG have a joint venture underway to produce larger and more complex components in pyrolytic boron nitride by chemical vapor deposition. This should make Fulmer a leading manufacturer of these specialized ceramic components, used extensively in semiconductor manufactures.

#### 4 ELECTRONICS AND INFORMATION TECHNOLOGY

The activities of this division cover a wide range of electronics and information technology and include licensing and industrial projects.

##### Computer Systems

Sofchip Technology is a system for the development of operational embedded computer systems which might be used in process plants, communications networks, or aircraft. It was conceived and developed by Advanced Systems Architecture Ltd., a company formed in 1984, with joint-venture funding from BTG.

Sofchip includes:

1. A set of software tools for system specification and software development, using both graphical and textual representation
2. An arrangement for automatically realizing the target system as a number of intercommunicating modules (called Sofchips), each of which is dedicated to a particular function within the total system
3. Special equipment to implement the resulting system and prevent any possibility of interference between the different Sofchips.

Another BTG investment is with Deductive Systems Ltd., a company which is developing a multiterminal fifth-generation microcomputer with the University of Strathclyde. Alvey funding has also been secured.

BTG holds the original Alice patents derived from work at Imperial College of Science and Technology, and has made



these available to participants in FLAGSHIP, the major Alvey Project on computer architecture.

#### Computer Software

Support has been provided for work at Imperial College on the Simulation Program for the Exploration, Evaluation, and Design of Unsteady Processes (SPEED UP), which is a software package enabling chemical engineers, designing process plants and their control systems, to explore steady-state and dynamic behavior. Prosys Technology Ltd. has been appointed as the first commercial distributor for SPEED UP. The program is being evaluated by British Petroleum, Exxon, and Air Products.

BTG has funded development work at Imperial College and the University of Waikato in New Zealand, in association with Philips Research Laboratories, to produce a software package called MINNIE, for the computer-aided design of electronic circuits. The software is being licensed to Interactive Solutions Ltd. and Amazon Computers Ltd.

A set of computer programs called the Rutherford Magnetics Software was assigned to BTG for exploitation by the Rutherford Appleton Laboratory. The programs are to aid the design of equipment involving electromagnetic fields. These programs are now licensed to Vector Fields Ltd., a new specialist company spun off from Rutherford Appleton by authors of the software. Licensing and marketing arrangements have been established to cover the UK, North America, and parts of Europe, and some sales have already been made in the Far East.

The Rutherford Intermediate Format is a package of software to support the vector-scan electron beam lithography machines used in semiconductor production. This software has been assigned by Rutherford Appleton to BTG for exploitation. The system acts as an interface between the circuit layout software and the machine control software. It allows common operations to be performed on data irrespective of the particular electron-beam microfabricator being used.

Software protection is being addressed by a consortium of companies in association with the National Physical Laboratory. The approach is to protect a small but crucial module of software in encrypted programs, which are only available when the software protection device is plugged into the computer.

#### Words and Music

BTG has invested over £500,000 (\$825,000) on the development by PA Technology of a low-cost, high-accuracy speech recognition machine. A prototype demonstrator and several evaluation units have been built. Tests using live speech have shown that preselected words or phrases can be recognized within continuous speech in real time. The next phase, for which a commercial partner is being sought, is to engineer the design for volume production.

BTG began support in 1982 for a project with Nimbus Records to develop mastering equipment and processing plant for compact disks. The Nimbus production facility is now the second largest in Europe and anticipated the launch of compact disks in the UK and subsequent consumer demand.

Work has also continued on the synthesis of musical sounds, particularly on the Bradford Organs, for which a number of licenses have been concluded.

BTG is supporting the Oxford Music Processor, developed at Oxford University by Richard Vendome. The virtues of this processor are the alphanumeric code used for entries and the automatic handling of many of the subtle tasks of proportioning needed to provide an attractive layout for musical scores.

The Oxford Faculty of Music with support from BTG is sponsoring the conversion of the Oxford Music Processor to run on personal computers, and license negotiations are underway with Oxford University Press.

#### Amorphous Silicon

BTG has been sponsoring development work on integrated circuits and silicon devices for the past 3 years at Imperial College. Work has centered on a new

method for the production of amorphous silicon, which is used in the fabrication of solar cells and photoconductive layers for xerographic applications. The new method, activated reactive evaporation, allows silicon to be deposited very much faster than the conventional glow-discharge technique while maintaining the quality of the final film. It is also safer, since the source of the silicon is an ingot rather than hazardous silane gas.

A patent application has been filed in the UK and overseas and BTG is now seeding licenses for the next stage of commercial exploitation.

#### Displays and Image Processing

About £300,000 (\$500,000) has been spent in support of Imperial College and the development of flat-panel technology using an array of cadmium selenide thin-film transistor elements to drive liquid crystal pixel elements. The transistors respond quickly to the drive signals and are designed to have a high impedance so as to sustain the drive signals on the liquid crystal display. Experiments indicate that a 2000-line display is feasible and BTG is discussing with industry a project to develop a television resolution display.

Work is also continuing on electrochromic technology to produce the pixels required for a large-area public address system. Electrochromics have the advantage that the state of a pixel is maintained without energizing the display until it is necessary to change the element by a further drive signal.

University College, London, has been involved in the development of image processing for many years and the Cellular Logic Image Processor (CLIP)4 array has been licensed to Stonefield Systems plc of Horsham. The system is now manufactured in modules of 16x32 cells, which enables systems of different sizes to be assembled. A minimum system costs about £20,000 (\$33,000) and incorporates the necessary hardware and software to accept and process an image from a television camera and display the results on a television monitor. Applications have thus

far been in medical imaging and inspection, which can be performed in real time. The University College system incorporating a 96x96 cell array won the 1985 Technical Award of the British Computer Society (ESN 41-8:422-425 [1987]).

#### Some Campus Companies

BTG provides support for two new companies which originated from the University of Hull and are now located in the University Science Park. Laser Monitoring Systems Ltd. produces a range of semiconductor emitters and detectors, including tunable laser diodes, for use at infrared wavelengths.

Metaforth Computers Ltd. manufactures a single-board computer with a new design of processor architecture that enables it to operate at 7 million high-level instructions per second.

Data communications services, with an emphasis on a videotex bureau services for access by shipping, are being provided by a new company, Information Management Consultants Ltd., in Liverpool Polytechnic. The company also offers videotex consultancy services, software and training.

### 5 ENGINEERING SCIENCES

Emphasis in this division is on scientific and industrial instruments, safety equipment, and medical equipment. It also deals with developments in engineering related to fluid power, measurement and control, food, and agriculture.

#### Scientific Instruments

Electrochemical gas-sensor technology from the laboratories of Health and Safety Executive has been exploited successfully for some years by licensing through BTG. Recent improved technology from these laboratories involving several new inventions has led to further licenses and license negotiations by BTG. The improvements cover many applications including analysis of flue gases and fast-response measurement of oxygen in anesthetic systems.

Also the National Physical Laboratory (NPL) has produced another instrument for gas analysis. It was originally devised as a wavelength corrector. However, it also has application as an interferometric refractometer for precise analysis of binary gas mixtures. An instrument for this purpose is now being produced by Index Instruments Ltd. for analysis of medical gas mixtures, but with potential in other areas where measurement of the refractive index of gases or gas mixtures to 1 part in  $10^8$  is needed.

NPL has also invented a surface profile interferometer, developed for the measurement of residual roughness on super smooth surfaces produced by polishing or diamond turning. The NPL system can measure features less than 0.1 nm in diameter. The prototype has been used successfully to investigate ring laser gyro mirror substrates and diamond-turned metal mirrors. A commercial system is being produced by Cranfield Precision Systems Ltd.

#### Laboratory Equipment

The Center for Tissue and Cell Research at York University has recently completed a BTG-funded project to produce an automatic critical point drier for the preparation of samples for electron microscopy. A microprocessor controller is used to monitor critical parameters in the drying process so that specimens can be produced with minimal operator intervention and to a high degree of consistency.

BTG is funding vacuum engineering research at the Polytechnic of Wales and Leisk Engineering Ltd. Polytechnic of Wales has proposed new devices for gas analysis or leak detection. They are based on quadruple ion stores, which offer great potential for compact analysis of gases by identifying the individual component mass.

#### Safety Devices

On the basis of research in the laboratories of the Health and Safety Executive a self-contained powered respirator for protection against dust and

vapors was licensed by BTG to Pureflo Safety Ltd.

The STAMP air-aspirating fire-detection system produced under BTG license by Guardian Fire Detector Systems Ltd. has recently received a boost through the acquisition of Guardian and further investment by First Security Group plc. New versions of STAMP have been introduced.

#### Nondestructive Testing and Condition Monitoring

A thermal wave imaging system, developed with BTG funding at the University of Manchester is now being manufactured under license by EDT Research. This equipment, using a photoacoustic sensor pioneered by EDT, is intended for nondestructive microscopic examination of the surface and subsurface properties of metals, surface coatings, semiconductor devices, and biological materials.

Through developments at Loughborough University of Technology electronic speckle pattern interferometry (ESPI) is now finding increasing application in nondestructive testing. Technical developments have made possible high-performance ESPI equipment at modest cost, and commercial equipment is available through BTG's licensees, Ealing Electro-optics plc and Newport Corporation.

The application of ESPI to rotating bodies is being investigated at the City University. Other work in nondestructive testing is underway at Birmingham Polytechnic, the Imperial College of Science and Technology, Matwal Ltd., H. Tinsley and Co., Ltd., Fulmer Components Ltd., and British Hydromechanics Research Association (BHRA).

#### Fluid Technology

High-pressure underwater cleaning equipment developed by BHRA with BTG assistance has been the subject of an option agreement between BTG and Wharton Williams Ltd. The equipment will be used to clean corrosion and marine growth from welds in offshore structures. Trials offshore using a remotely operated vehicle are planned for 1987.

The technology of electrorheological fluids, conducting suspensions in nonconducting fluids, has been developed at the University of Sheffield and Liverpool with support from the Ministry of Defense, the Science and Engineering Research Council, and BTG. There are potential applications in variable-rate mechanical fluid drives and dampers.

Recently Castrol Ltd, ER Fluid Development Ltd, ICI, and American Cyanamid Company have signed licensing agreements with BTG for worldwide exploitation.

#### Agriculture Engineering

About 24 new patent applications in this area were filed with BTG during the last year. Applications include: an efficient means of taking grain from a cereal stalk and leaving the straw standing (National Institute of Agricultural Engineering); a hydraulic milking device (National Institute for Research in Dairying); and a broiler harvester that carefully lifts the birds off the floor of the broiler house (National Institute of Agricultural Engineering).

#### Medical Equipment

Musgrove Park Hospital, Belfast, with support from Richards Medical Company Inc. is developing equipment for the diagnosis of congenital disorders of the hip. Both Richards Medical Company and Corin Medical Ltd. have been granted licenses to sell the cancellous bone pin which was developed at the London Hospital and Imperial College of Science and Technology.

BTG-funded work at the Bristol and Western General Hospital led to the construction of five production models of an ultrasonic blood-flow meter by Vital Science Ltd. The company expects to also sell this product in Europe and the US.

Other medical equipment research is underway at the Royal Military College of Science, Microwave Engineering Designs Ltd., the University of Newcastle, and Bellhouse Medical Products Ltd.

## 6 CIVIL, ELECTRICAL, AND TRANSPORT ENGINEERING

#### Civil Engineering

Geomensor, a surveying instrument based on research at National Physical Laboratory, uses a modulated light beam, reflected from a distant target, to measure distance to an accuracy of 0.5 mm at a distance of 1 km. It was developed by Com-Rad Electronic Equipment Ltd. with financial support from BTG.

Laserfix, invented at Northeast London Polytechnic, uses an unattended rotating compound laser beam to provide reference information for a surveyor using a spatial electronic receiving staff. The three-dimensional coordinates of the point being measured are instantly displayed on the staff. Several users can work independently on a site with a single laser transmitter. BTG provided most of the development funds. Along with private financial interests, BTG invested in Laserfix Ltd., the company formed to commercialize the product.

#### Electrical Engineering and Electronic Instruments

The pole-amplitude modulated motor, invented at Bristol University and developed with BTG support runs at two distinct speeds, by switching the connections to a single, specially designed stator winding. License income from this product now totals £1.5 million (\$2.5 million).

Cotswold Research Ltd. received the Prince of Wales Award in 1986 for its Cotswold Separator, developed with BTG support. The separator uses linear-motor technology for the reclamation of nonferrous metals from scrap refuse.

B and R Electrical Products Ltd. won the Hardware Trades Journal "Product of the Year Award" in 1985 for the Power-breaker 20 electrical adapter. This is a 13-A plug adapter with built-in earth leakage protection. BTG helped finance its development.

Other devices financed by BTG include: Home Automation Ltd.'s mains signalling system for lighting energy management; Datron International's digital

voltmeters; and an induction motor controller at the University of Sussex.

### Transport Engineering and Power Generation

The Perbury continuously variable transmission (CVT) automatically provides a drive ratio that will permit an engine to run at a special speed that offers optimum performance for the power demanded. This development at Perbury Engineering and Strathclyde University was fully funded by BTG.

BTG is currently supporting a company in Manchester in its development of a new range of combined heat and power units. The company has found ways to improve system reliability and thus achieve the same confidence that a customer has in mains gas and electricity.

At Cranfield Institute of Technology work is underway on arrays of wing tip sails for airplanes that reduce the effects of the tip vortex due to air flow and also modify the flow pattern to generate a forward thrust, which gives improved aircraft efficiency.

## 7 INDUSTRIAL ENGINEERING

This division deals with robotics and automation, computer-aided design and manufacture, and metal and plastics cutting, forming, and processing.

### Steel Industry

Davy McKee (Sheffield Ltd.) has recently received an order from Compagnie Francaise de Forge at Fonderies for a twin-strand Horicast continuous casting machine. The plant will be used to produce 20,000 tons per year of stainless-steel rounds and square billets. Early development costs were shared by BTG through a joint venture in the mid-1960's. Further development was continued by Davy McKee and NKK of Japan, and NKK installed a Horicast plant at Olurra in Spain at the end of 1986.

### Factory Equipment

BTG provided joint-venture funding with Pyroban Ltd. for development of an

electronic gas detection system for the automatic shutdown of electrically powered vehicles operating in potentially hazardous areas. The system was announced in February 1986 and is marketed as the Pyroban-3000.

In 1980 BTG provided initial support to Radiation Dynamics Ltd. to develop an electron beam sterilizing machine. Since a Government appointed committee has reported that irradiation of food within specified limits is an acceptable method of preservation there may be market potential for a product in the area.

### Computer Aided Design

The Genesys computer aided design (CAD) system, originally a batch processing system, has recently been updated and rewritten by Lamp Software Ltd., under BTG license. It can now operate in either interactive or batch mode on recent 32-bit workstations, e.g., Digital's VAX station.

Genesys software is applicable to bridge design, road design, and structural analysis of large buildings and other aspects of civil and structural engineering.

The University of Reading has developed software for predicting the likely duration and cost of construction industry projects. Uncertainties influencing the progress of a project are categorized as interferences that cause work to cease and variability of human performance and capability. A project is simulated as a collection of interlinked operations, with emphasis on graphic presentation and ease of use.

The software is designed to help clients, consultants, and contractors to set realistic objectives and identify problem areas.

## 8 COMMENTS

It seems apparent that the role of BTG in the transfer of new ideas and technology from university and government laboratories to industry is a very important matter. This has clearly been

happening extensively since BTG came into existence 6 years ago.

An auxiliary function of managing patents and the licensing of technology to a company is also important and, in fact, an indispensable corollary to the technology transfer function.

The funding of research and development is quite significant at \$10 million (\$16.5 million) per year now and going to nearly double by 1990. The selection of projects for funding appears to be based on expectation of commercial results in the not too distant future.

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